Energy, Mines and Resources Canada | Énergie, Mines et Ressources Canada

CANMET

Canada Centre for Mineral and Energy Technology | Centre canadien de la technologie des minéraux et de l'énergie

SIMBAL - A COMPUTER PROGRAM FOR MINERAL PROCESSING CIRCUIT SIMULATION USER'S GUIDE

M. Bilodeau, D. Laguitton
Mineral Processing Laboratory

October 1988

Project: 30.13.01
Computer Aided Mineral Processing

MICROMEDIA

27 pp

MINERAL SCIENCES LABORATORIES
DIVISION REPORT MSL 89-31 (TR)

Energy, Mines and Resources Canada | Énergie, Mines et Ressources Canada

CANMET

Canada Centre for Mineral and Energy Technology | Centre canadien de la technologie des minéraux et de l'énergie

MICROCOMPUTER SOFTWARE FROM CANMET

CAMP
Computer Aided Mineral Processing
555 Booth Street
Ottawa, Ontario K1A 0G1
Canada

SIMBAL

A COMPUTER PROGRAM FOR MINERAL PROCESSING CIRCUIT SIMULATION

USER'S GUIDE

M. BILODEAU, D. LAGUITTON

October 1988

CAMP

COMPUTER AIDED MINERAL PROCESSING

CANMET, Energy, Mines and Resources Canada,

552 Booth Street, Ottawa, Ontario, Canada K1A 0G1

TABLE OF CONTENTS

1. INTRODUCTION 1
2. GETTING STARTED 2
2.1 Hardware Requirements 2
2.2 Software Requirements 2
2.2.1 Executable version 2
2.2.1.1 Files on diskettes 2
2.2.2 Source version 3
2.2.2.1 Files on diskettes 3
2.2.3 Operating system 4
2.3 Program Compilation 4
2.4 Program Installation 5
2.4.1 Setting up a subdirectory 5
2.4.2 Storing files in SIMBAL subdirectory 5
2.4.3 Selection of the colours used in SIMBAL 6
2.4.4 Miscellaneous 6
3. PROGRAM STRUCTURE 7
3.1 SIMBAL.EXE 7
3.2 Utility Data Files 8
3.3 Simulator Data Files 8
3.4 Executable Procedures and Simulation Modules 8
3.5 Output Files 8
3.6 User Data File 8
3.7 Debugging Files 8
4. PROGRAM OPERATION 9
4.1 Simulator Selection 9
4.2 Menu Options 9
4.3 Messages 10
4.4 Help 10
4.5 The Flowsheet Creation Options Screen 10
4.6 The Drawing Board 11
4.6.1 The drawing board functions 11
4.6.2 The drawing board access 11
4.6.3 The drawing board help text 11
4.6.4 Flowsheet generation 11
4.6.4.1 Drawing units 13
4.6.4.2 Drawing streams 14
4.6.5 Simulation data entry 14
4.6.5.1 Stream connection matrix 14

4.6.5.2 Circuit feed description and water addition flowrates 15
4.6.5.3 Unit model parameters 17
4.7 Simulation Execution 17
4.8 Simulation Results 17
4.8.1 Results around a specific unit 18
4.8.2 Final results 18
5. PROGRAM CAPABILITIES 20
6. SAMPLE RUN 21
7. MAINTENANCE AND UPDATES 21
8. ACKNOWLEDGEMENTS 21
9. REFERENCES 22

1. INTRODUCTION

The simulation of mineral processing circuits, which consists of evaluating liquid and solid distributions on all streams of a flowsheet, is applied to investigate flowsheet modifications, to perform off–line optimization and to design new plants.

At the Canada Centre for Mineral and Energy Technology (CANMET), four simulation modules developed for mineral processing circuits have been grouped in one computer program called SIMBAL. This system consists of a main driver, SIMBAL, and four simulation modules: HCONEX, SPLITX, FLOTEX and GRNDEX.

The main driver allows the user to supervise the complete system and to enter all data required to perform a simulation, i.e., feed description, unit model parameters and description of the flowsheet. The flowsheet description is entered by drawing it on the screen; the streams are drawn directly, and the units are recalled from a list of predefined modules. Once a flowsheet is drawn, the entry of feed data and unit parameters is activated by moving the cursor to the stream or unit and pressing a preprogrammed key. The program then prompts the user with a table in which all the data required can be entered or modified by using full screen editing facilities. After all required data have been entered, the execution of the simulation module can be initiated from the main menu. The results can then be printed for the whole circuit or displayed for a specific unit by moving the cursor to the selected unit and pressing a preprogrammed key.

The simulation modules contain all the necessary instructions to conduct a flowsheet decomposition and material balance simulation. They are controlled directly from the main driver SIMBAL. SPLITX is a predictive material balance module in which the unit model is based on split coefficients associated with all classes and subclasses describing the feed (1). The program is general and can be applied to any material handling circuit. The other three simulators are more complex and have a specific application: HCONEX simulates hydrocyclone networks; GRNDEX simulates grinding circuits; and FLOTEX simulates flotation plants.

2. GETTING STARTED

2.1 Hardware Requirements

- IBM-PC(*), PC XT, PC AT, 386 or compatible
- 640 KB of RAM memory
- 1 Hard disk drive (10 MB or more)
- 1 Soft disk drive (360 KB)
- IBM Colour Graphic Adapter (CGA)
- IBM monochrome composite or RGB colour monitor
- IBM compatible printer like Epson, Panasonic, etc.

The following equipment is optional:

- 1 Math coprocessor 8087
- 1 Epson HI-80 plotter

2.2 Software Requirements

Depending on whether the source or executable version is received, the user diskettes contain the following software.

2.2.1 Executable version

The SIMBAL program resides on four 5¼-inch diskettes (non copy protected): diskette 1, SIMBAL; diskette 2, GRNDEX/FLOTEX; diskette 3, SPLITX/HCONEX; diskette 4, SAMPLE RUN + INSTALL.

2.2.1.1 Files on diskettes

Diskette number	Title	Files
1	SIMBAL	FLO.TXT
		FLOTEX.TXT
		GRNDEX.TXT
		HCONEX.TXT
		HFLOTEX.BAT
		HGRNDEX.BAT
		HHCONEX.BAT
		HSPLITX.BAT
		SCREEN.DAT
		SIMBAL.EXE
		SIMBAL.UNT
		SPLITX.TXT
		UNITS.DAT

(*) IBM is a registered trademark for International Business Machines.

2	GRNDEX/FLOTEX	FLOTEX.EXE GRNDEX.EXE
3	SPLITX/HCONEX	FINPRT.EXE FLOWAN.EXE HCONEX.EXE MATFLO.EXE
4	SAMPLE RUN +INSTALL	FLOTEX.SMB GRNDEX.SMB HCONEX.SMB SPLITX.SMB INSTALL.DAT INSTALL.EXE

2.2.2 Source version

The SIMBAL program resides on six 5¼-inch diskettes (non copy protected): diskette 1, SIMBAL; diskette 2, GRNDEX; diskette 3, SPLITX; diskette 4, FLOTEX/HCONEX; diskette 5, SAMPLE RUN + INSTALL; diskette 6, SPOC LIBRARY.

2.2.2.1 Files on diskettes

Diskette number	Title	Files
1	SIMBAL	FEED.FOR FILERS.FOR FLO.TXT FLO1.FOR FLO2.FOR FLOTEX.TXT FLOTIN.FOR GRNDEX.TXT GRNDIN.FOR HCONEX.TXT HCONIN.FOR HFLOTEX.BAT HGRNDEX.BAT HHCONEX.BAT HSPLITX.BAT INTFLO.FOR SCREEN.DAT SIMBAL.FOR SIMBAL.UNT SPLIN.FOR SPLITX.TXT UNITS.DAT UTIL.FOR

2	GRNDEX	GRNDEX.FOR GRNDN.FOR GRNDN1.FOR GRNDN2.FOR GRNDN3.FOR GRNDX2.FOR GRNPRT.FOR
3	SPLITX	FINPRT.FOR FLOWAN.FOR FLSUB1.FOR FLSUB2.FOR FLSUB3.FOR FLSUB4.FOR FLSUB5.FOR MATFLO.FOR MATF1.FOR MATF2.FOR MATF3.FOR MATF4.FOR
4	FLOTEX/HCONEX	FLOTEX.FOR FLTCL1.FOR FLTCL2.FOR FLTPRT.FOR HCONEX.FOR HCONE1.FOR HCONE2.FOR HCONE3.FOR HCSPRT.FOR
5	SAMPLE RUN +INSTALL	INSTALL.DAT INSTALL.FOR FLOTEX.SMB GRNDEX.SMB HCONEX.SMB SPLITX.SMB
6	SPOC LIBRARY	SPOC2.LIB

2.2.3 Operating system

MS-DOS Version 3.00 or higher. The ANSI driver system must be installed; see your DOS manual for more information (2).

2.3 Program Compilation

If the source version is used, all the files must be compiled using the Microsoft Fortran Compiler, Version 4.01 (3). Refer to user's guide to install the compiler.

All files with extension "FOR" must be compiled using the following commands:

```
FL /FPi /c /Od /W0 INSTALL.FOR
FL /FPi /c /Od /W0 MATFLO.FOR MATF1.FOR MATF2.FOR MATF3.FOR
                   MATF4.FOR
FL /FPi /c /Od /W0 FLOWAN.FOR FLSUB1.FOR FLSUB2.FOR
                   FLSUB3.FOR FLSUB4.FOR FLSUB5.FOR
FL /FPi /c /Od /W0 FINPRT.FOR
FL /FPi /c /Od /W0 FLOTEX.FOR FLTCL1.FOR FLTC2.FOR FLTPRT.FOR
FL /FPi /c /Od /W0 HCONEX.FOR HCONE1.FOR HCONE2.FOR
                   HCONE3.FOR HCSPRT.FOR
FL /FPi /c /Od /W0 GRNDEX.FOR GRNDX2.FOR GRNDN.FOR GRNDN1.FOR
                   GRNDN2.FOR GRNDN3.FOR GRNPRT.FOR
FL /FPi /c SIMBAL.FOR FLO1.FOR FLO2.FOR INTFLO.FOR UTIL.FOR FEED.FOR
           FILERS.FOR FLOTIN.FOR SPLIN.FOR HCONIN.FOR GRNDIN.FOR
```

They are then linked in the following way:

```
LINK  INSTALL,,,LLIBFORE+LCLIB1+SPOC2;

LINK  SIMBAL+FLO1+FLO2+INTFLO+UTIL+FEED+FILERS+FLOTIN+
      SPLIN+HCONIN+GRNDIN,,,LLIBFORE+LCLIB1+SPOC2;

LINK  FLOWAN+FLSUB1+FLSUB2+FLSUB3+FLSUB4+FLSUB5,,,
      LLIBFORE+LCLIB1;

LINK  MATFLO+MATF1+MATF2+MATF3+MATF4,,,LLIBFORE+LCLIB1;

LINK  FINPRT,,,LLIBFORE+LCLIB1;

LINK  FLOTEX+FLTCL1+FLTCL2+FLTPRT,,,LLIBFORE+LCLIB1;

LINK  HCONEX+HCONE1+HCONE2+HCONE3+HCSPRT,,,LLIBFORE+LCLIB1;

LINK  GRNDEX+GRNDX2+GRNDN+GRNDN1+GRNDN2+GRNDN3+GRNPRT,,,
      LLIBFORE+LCLIB1;
```

2.4 Program Installation

The following instructions assume that the user has received the executable version. If the source version is used, it is necessary to create a set of executable disks, as presented in section 2.2.1 (Executable version), before using these instructions.

2.4.1 Setting up a subdirectory

Return system to root directory (C> or D>), type MD\SIMBAL and press <RETURN>. A subdirectory called SIMBAL will be created. Any name, other than SIMBAL, can be used.

2.4.2 Storing files in SIMBAL subdirectory

1. To access the subdirectory SIMBAL, type CD\SIMBAL at the DOS prompt.

2. Insert the four diskettes sequentially in drive A and type COPY A:*.* at each DOS prompt. All the files on the four diskettes are then copied to the subdirectory SIMBAL.

2.4.3 Selection of the colours used in SIMBAL

All the colour codes used in SIMBAL can be changed with the program INSTALL.EXE. A help text showing all the possible colours with their numeric codes is supplied with the INSTALL program. The user will notice that a different method must be used to enter the colour used by DOS. The background and foreground colour codes must be specified because the colour is fixed using the ANSI driver technique instead of the ROM BIOS technique. Further information on this subject may be found in the literature (4, 5, 6).

2.4.4 Miscellaneous

1. Before running SIMBAL, the user must ensure that no large programs such as SideKick (7) are resident in memory.

2. To print the flowsheet on the printer by using the combination of keys Shift and PrtSc, the user must include the statement GRAPHICS in the AUTOEXEC.BAT file. Check the disk operating system manual (2) for more information about the GRAPHICS command and the AUTOEXEC.BAT file.

3. PROGRAM STRUCTURE

The SIMBAL system consists of one main driver (SIMBAL), which supervises the execution of the program, and four batch files (HSPLITX.BAT, HHCONEX.BAT, HGRNDEX.BAT, HFLOTEX.BAT), which control the execution of the respective simulation modules, and the simulation modules themselves (FLOWAN.EXE, MATFLO.EXE, FINPRT.EXE, HCONEX.EXE, FLOTEX.EXE, GRNDEX.EXE). The link between all these programs is insured by data files. Figure 1 shows a general overview of the complete system.

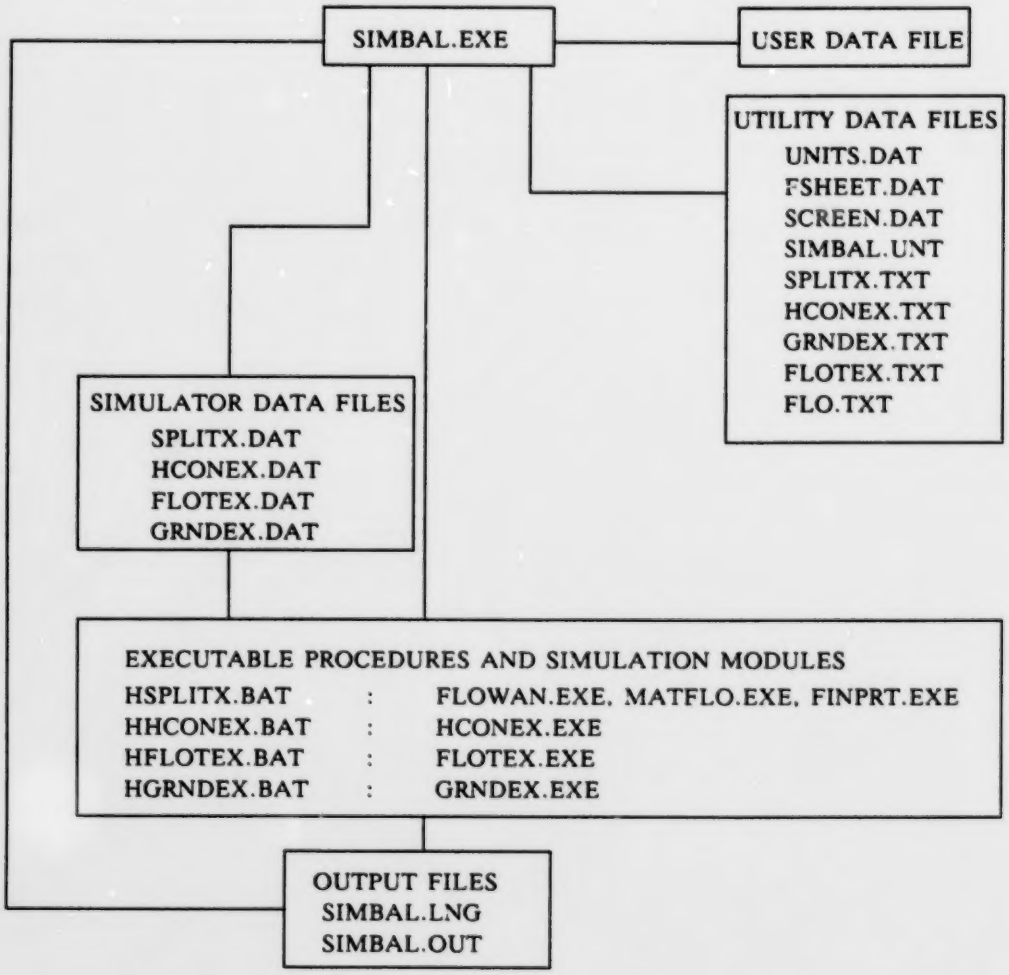

Figure 1: Structure of SIMBAL system

3.1 SIMBAL.EXE

SIMBAL contains two main modules: the main menu from which the complete operation of the program is controlled and the editor used to draw the flowsheet and to enter all data needed for the simulation.

3.2 Utility Data Files

These files contain operating data for SIMBAL. They must not be modified by the user.

SCREEN.DAT	:	Data required to display the screen used for unit parameters and feed data entry.
SIMBAL.UNT	:	Data required to display the main menu screen.
UNITS.DAT	:	Contains predefined unit diagrams. This file is created by a separate program called DRAW, which allows the user to create his/her own unit diagrams. DRAW is not included with SIMBAL but is available separately.
FSHEET.DAT	:	Temporary file used to keep a record of the flowsheet.
HCONEX.TXT	:	Help text for HCONEX simulator.
GRNDEX.TXT	:	Help text for GRNDEX simulator.
FLOTEX.TXT	:	Help text for FLOTEX simulator.
SPLITX.TXT	:	Help text for SPLITX simulator.
FLO.TXT	:	Help text for drawing board.

3.3 Simulator Data Files

These files are created by the main driver (SIMBAL) and used by the four simulators (FLOWAN.EXE, HCONEX.EXE, FLOTEX.EXE, GRNDEX.EXE). They contain all the data required to perform a simulation.

3.4 Executable Procedures and Simulation Modules

These programs analyze the flowsheet and execute the simulation by using the appropriate unit models. The simulation results are temporarily written to the two output files SIMBAL.LNG and SIMBAL.OUT. Further information about the flowrate calculation technique and unit simulation models may be found in SPOC manual, Chapter 6, SPLITX, GRNDEX, HCONEX, FLOTEX (11).

3.5 Output Files

These two output files contain the same results presented in two different forms.

SIMBAL.OUT: The results are displayed for each unit. This file is used to scan the results around a specific unit.

SIMBAL.LNG: The results are presented stream by stream. This file is used to print the complete distribution of material on all streams.

3.6 User Data File

This file contains all data entered by the user, i.e., flowsheet, feed description and unit parameters. The name is selected by the user. Four user data files are supplied with the system: SPLITX.SMB, HCONEX.SMB, GRNDEX.SMB, FLOTEX.SMB. They contain a sample run for each simulator.

3.7 Debugging Files

For SPLITX, two files (FLOWAN.LOG and MATFLO.LOG) contain supplemental results about flowsheet analysis and flowrate convergence calculations.

4. PROGRAM OPERATION

To start the program, the user must access the SIMBAL subdirectory (CD\SIMBAL) and then load the program in memory by typing SIMBAL on the keyboard. The main menu of the program is then displayed on the screen as shown in Figure 2.

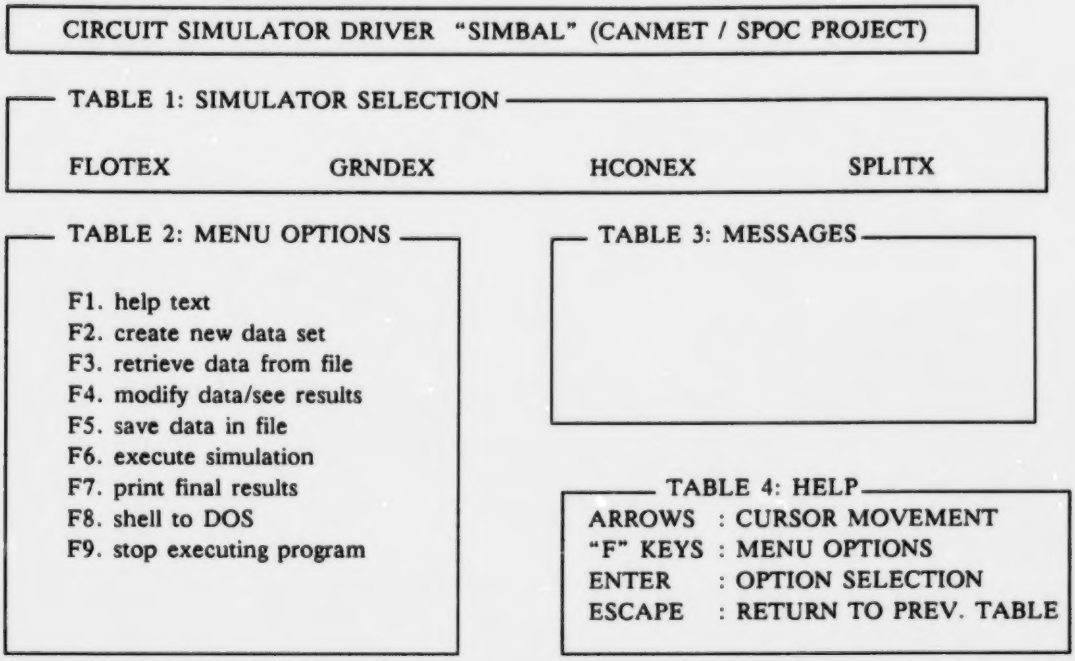

Figure 2: SIMBAL main menu

4.1 Simulator Selection

From Table 1 in Figure 2, the required simulation module is selected by moving the highlighted bar to the chosen option (with the arrow keys) and pressing the <RETURN> key.

Select:

1. SPLITX : to use the general simulator in which the unit model parameters are split coefficients associated with all the classes and subclasses of the feed. SPLITX simulates flowsheets involving separators and mixers.
2. HCONEX : to simulate flowsheets involving hydrocyclones and mixers.
3. GRNDEX : to simulate grinding circuits involving rod mills, ball mills, hydrocyclones, extrapolation modules (to simulate the extrapolation of a size distribution in the fine size ranges) and mixers.
4. FLOTEX : to simulate flotation plants involving flotation cells and mixers.

Note: For further information on simulation modules and on the unit models used, the user is referred to SPOC manual, Chapters 5, 5.1, 5.2 and 6 (8, 9, 10, 11).

4.2 Menu Options

In this menu, the available options are initiated by either pressing the corresponding <F> key or moving the highlighted bar to the chosen option and pressing the <RETURN> key.

Select:

F1: to visualize the help text associated with the simulator selected in Table 1 of Figure 2.

F2: to delete present data and create a new data set.

F3: to delete present data and load a new data set from disk file.

F4: to modify a set of data already loaded in memory or to display the results around a unit.

F5: to save the present data set in a disk file.

F6: to run the simulation module selected in Table 1 of Figure 2.

F7: to print the simulation results and all input data.

F8: to shell to DOS.

F9: to stop program.

4.3 Messages

Table 3 on the main menu (Figure 2) is used by the program to communicate with the user.

4.4 Help

The small help text in Table 4 indicates how an option is selected on the main menu.

1. Arrows: cursor movement
   - arrow keys located on the keypad permit movement of the highlighted bar in the active table (the active table is the table containing the blinking cursor).
2. <Enter>: option selection
   - <RETURN> key can be used to select the option highlighted by a bar in the active table.
3. <F> keys: menu options
   - <F> keys can be used to select an option independently of the active table.
4. <Exc>: return to previous table
   - Escape key is used to exit present table and return to previous one. When Table 1 is active, the <RETURN> key works in the opposite way.

4.5 The Flowsheet Creation Options Screen

When option <F2> (create new set of data) is selected from the option menu, the flowsheet creation options, as shown in Figure 3, are displayed.

FLOWSHEET CREATION OPTIONS

UNIT SCALE (1:5x8 mm, 10:50x80 mm)	:	3
STREAM/UNIT NUMBERING (0:MANUAL / 1:AUTO)	:	1
F9: Keyboard Help	F10: Save and Exit	Esc: Exit without saving

Figure 3: Flowsheet creation options

1. Unit Scale (1–10):

   This factor is used to size unit diagrams with an absolute value. A value of 2. for example, produces unit diagrams twice as big as a value of 1, which exhibits unit diagrams about 5 mm high by 8 mm wide. A value of 3 is recommended.

2. Stream/Unit Numbering:

   Select 0 if stream and unit numbers must be entered manually. Select 1 if stream and unit numbers must be generated automatically by the program.

Note: Manual numbering is available in SPLITX only.

4.6 The Drawing Board

4.6.1 The drawing board functions

The drawing board in SIMBAL has three different functions:

1. to draw the flowsheet;
2. to enter feed description and unit model parameters;
3. to display simulation results around a specific unit.

4.6.2 The drawing board access

To access the drawing board, select one of the following options from the main menu:

F2. create new set of data;
F3. retrieve data from file;
F4. modify data/see results.

4.6.3 The drawing board help text

The help text contains a definition of all the preprogrammed keys used on the drawing board. It is displayed (Figure 4) before accessing the drawing board and can also be consulted later from the drawing board by pressing the <?> key. From the help text the user can return to the main menu by pressing <Q> or <Esc> or go to the drawing board by pressing <F10>.

4.6.4 Flowsheet generation

Figure 5 shows the screen image of a flowsheet. Streams are drawn directly on the screen and units are recalled from a list of predefined modules contained in the data file UNITS.DAT. A list of available units is presented in Figure 6.

DRAWING BOARD HELP TEXT

The drawing board is used to:
1. Draw the flowsheet;
2. Enter feed data and unit parameters;
3. Visualize results around units.

NOTE: 1. It is strongly recommended that units be drawn before streams.
2. Print this help text (Shift-PScrn) for later consultation.

PROGRAMMED KEYS:

(S) START STREAM (ANY KEY FOR CORNER)
(T) TERMINATE STREAM
(U) PLACE UNIT
(C) COLOUR ALL UNITS
(D) DELETE UNIT/STREAM
(H) HARD COPY ON EPSON HI-80
(M) SEE STREAM CONNECTION MATRIX
(R) RESOLUTION HIGH/MEDIUM
(G) DISPLAY GRID
(N) REDRAW THE SCREEN

(I) INPUT FEED DATA OR UNIT PARAMETERS
(W) INPUT OF WEIGHTING FACTOR (SPLITX)
(O) RESULTS AROUND A UNIT AT CURSOR POSITION

(?) ACCESS THE PRESENT MENU AT ANY TIME FROM THE DRAWING BOARD
(Esc/Q) EXIT THE DRAWING BOARD AND RETURN TO MAIN MENU

Esc/Q: Go to main menu F10: Continue

Figure 4: The drawing board help text

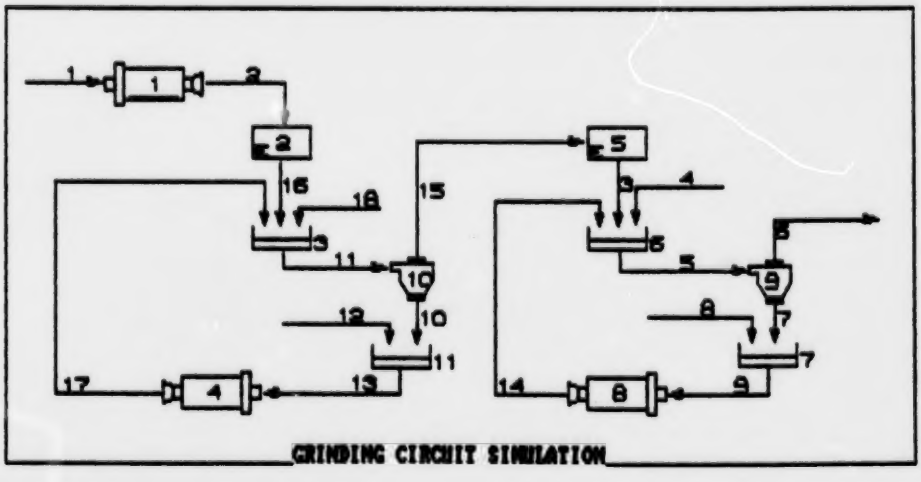

Figure 5: Flowsheet generated by SIMBAL

*** UNIT CODE LIST ***

NOTE: USE CAPITAL LETTERS TO ENTER UNIT CODES

UNIT CODE	UNIT DESCRIPTION
RML	ROD MILL
BML	BALL MILL
EXT	EXTRAPOLATION MODULE
MIX	MIXER
SEP	SEPARATOR
FLO	FLOTATION CELL
HYC	HYDROCYCLONE

PgUp/PgDn Home/End Esc: Exit

Figure 6: List of available units

4.6.4.1 Drawing units

To draw a unit on the screen, the following steps must first be taken:

1. Move the cursor to the desired location. Three different combinations of keys can be used to move the cursor:

   a. Arrow keys alone : the cursor is moved 8 pixels at a time.

   b. <Shift> + arrow keys : the cursor is moved 1 pixel at a time.

   c. <Ctrl> + arrow keys : the cursor is moved 16 pixels at a time; available only for left–right motion.

   Note: Depending on the state of the <NumLock> key, option 1 and 2 may be inverted.

2. Press <U> (for unit) on the keyboard.

   The following questions are then displayed at the top of the screen:

   a. Unit code, ? for list, X to exit ?

      You may enter:

      (1) unit code as shown in Figure 6 for the desired unit.

      (2) unit code plus <*>, e.g., BML*, to draw the unit with a rotation of 180 degrees around vertical axis in screen plane.

      (3) <?> to visualize the available unit list presented in Figure 6.

(4) <X> to exit unit drawing option.

b. Unit number ?

This question is displayed when manual numbering has been selected from the flowsheet generation options screen. Enter any number from 1 to 99 not already used.

c. Number location: use cursor, hit <space>

The user may accept the default position and press the space bar, or move the cursor to the desired location and press the space bar. The unit number is drawn next to the cursor (the reference point is the lower left corner of the number).

4.6.4.2 Drawing streams

To draw a stream on the flowsheet, the user must:

1. Move the cursor to the stream starting point and press <S> to activate stream drawing option.
2. If elbows or corners are required, move the cursor to the desired location and press any key (except <T>).
3. Press <T> to terminate stream drawing option. An arrow is automatically displayed.

At this stage the program displays questions related to stream numbering similar to the questions presented in section 4.6.4.1.

For GRNDEX, FLOTEX and HCONEX, the number of feed streams is limited to one and the solid feed should always be given number 1. For SPLITX, such a convention does not exist.

4.6.5 Simulation data entry

The data required to perform a simulation consist of:

1. stream connection matrix (see section 4.6.5.1);
2. description of the feed to the plant and all the water addition flowrates;
3. unit model parameters.

4.6.5.1 Stream connection matrix

The stream connection matrix is generated automatically (12) from the flowsheet on the drawing board. It can always be viewed by pressing the <M> key. The representation of the stream connection matrix associated with the flowsheet in Figure 5 is shown in Table 1.

In this table, the rows represent the streams: column 1 is the stream index; column 2 is the stream number; column 3 is the number of the originating unit; and column 4 is the destination unit number. Zero entries represent origins and destinations outside the flowsheet and are used to represent feed and output streams, respectively.

Table 1: Stream connection matrix of flowsheet in Figure 5

STREAM-INDEX	STREAM-NUMBER	ORG. UNIT	DEST. UNIT
1	1	0	1
2	2	1	2
3	3	5	6
4	4	0	6
5	5	6	9
6	6	9	0
7	7	9	7
8	8	0	7
9	9	7	8
10	10	10	11
11	11	3	10
12	12	0	11
13	13	11	4
14	14	8	6
15	15	10	5
16	16	2	3
17	17	4	3
18	18	0	3
PgUp/PgDn	Home/End	Esc: Exit	

4.6.5.2 Circuit feed description and water addition flowrates

To enter the feed description or water addition flowrates, the user must move the cursor to the corresponding stream on the flowsheet and press <I>. The program then displays two tables (Tables 2 and 3) into which may be entered all the information required to describe the feed to the plant.

As shown in Tables 2 and 3, the material constituting the feed and all other streams is defined by its solid and water flowrates and by the distribution of the solid phase along a maximum of 20 size intervals, 10 density intervals and four characteristics. The first characteristic is by convention the percentage of material contained in each size and density interval. Other characteristics may be chemical, energetic or mineralogical assays.

By convention, the solid flowrate and the number of sizes, densities and characteristics defining a water addition stream will be given a value of 0 because there are no solids in such a stream. Constraints for feed description are imposed by simulation modules. In GRNDEX, for example, the number of densities and characteristics is limited to 1. The user is referred to section 5 (PROGRAM CAPABILITIES) for more information.

Table 2: Table used to enter feed description and water addition flowrates

FEED DESCRIPTION

SOLID FLOWRATES (TPH)			:	125.0000
NUMBER OF SIZE INTERVALS			:	15
NUMBER OF DENSITY INTERVALS			:	1
NUMBER OF STREAM CHARACTERISTICS (>1 ONLY IN SPLITX)			:	1
WATER FLOWRATES (TONNES/HR)			:	27.0000
SPECIFIC GRAVITIES: (NOT USED IN SPLITX)				
4.5000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000
SIEVE APERTURES: (MICROMETRES)				
26900.0000	19024.0000	13454.0000	9515.0000	6729.0000
4759.0000	3366.0000	2380.0000	1683.0000	1190.0000
842.0000	595.0000	421.0000	298.0000	210.0000
.0000	.0000	.0000	.0000	.0000

NAME OF EACH COMPONENT: (USED IN FLOTEX ONLY)

F9: Keyboard Help F10: Save and Exit Esc: Exit without saving

Table 3: Table used to enter feed size distribution

FEED CHARACTERISTICS
(CHAR #1 % OF MATERIAL IN EACH NS, NG SUBCLASS)
(CHAR #2, 3, 4 RELATIVE TO CHAR #1)

NC	NS	NG :	
1	1	1	2.8000
1	2	1	11.2000
1	3	1	22.2000
1	4	1	11.4000
1	5	1	10.6000
1	6	1	7.8000
1	7	1	4.6000
1	8	1	4.2000
1	9	1	3.9000
1	10	1	2.9000
1	11	1	2.3000
1	12	1	1.7000
1	13	1	1.3000
1	14	1	1.2000
1	15	1	11.9000

F9: Keyboard Help F10: Save and Exit Esc: Exit without saving

4.6.5.3 Unit model parameters

The parameters defining unit models can also be entered by moving the cursor to the unit and pressing <I>. Depending on the unit code (BML, RML, EXT, MIX, SEP, FLO, HYC), the program prompts the user with the appropriate table. A representation of such a table is given in Table 4 for a ball mill unit.

For a separator unit, a convention is that the split factor is the fraction of the feed material that passes to the higher output stream on the screen. If the separator has three output streams, the second split factor applies to the second highest stream.

Table 4: Table used to enter ball mill parameters

BALL MILL PARAMETERS

GENERAL DATA:

NUMBER OF SIZE INTERVALS (PAN INCLUDED, MAXIMUM=20) :	15
NUMBER OF COMPONENTS (GANGUE INCLUDED, MAXIMUM=1) :	1

SPECIFIC DATA:

NUMBER OF B PARAMETERS (MAXIMUM=6) :	4
NUMBER OF S PARAMETERS (MAXIMUM=4) :	4
NUMBER OF PERFECT MIXERS (MAXIMUM=9) :	3
TOP SIEVE DIMENSION USED IN CALCULATING B, S (MM) :	11.4800

B PARAMETERS

.3985	.9199	20.0000	.1374	.0000
.0000				

S PARAMETERS:

253.0000	.6541	-.2261	-.1295

FRACTION OF TOTAL MEAN RESIDENCE TIME FOR EACH MIXER:

.5293	.1593	.0779	.0000	.0000
.0000	.0000	.0000	.0000	

F9: Keyboard Help F10: Save and Exit Esc: Exit without saving

For an explanation of the unit models as well as a description of their capabilities and limitations, the user is referred to SPOC manual, Chapters 5, 5.1, 5.2 and 6 (8, 9, 10, 11).

4.7 Simulation Execution

To execute the simulation, the user must first leave the drawing board and return to the main menu. This is done by pressing the <Q> or <Esc> keys. From the main menu, the option F6 (Execute simulation) must be selected. The simulation module indicated by the highlighted bar in Table 1 of Figure 2 is executed.

4.8 Simulation Results

After the simulation module has been executed, the user is returned to the main menu from which the results may be visualized in two different forms: final results or results around a specific unit.

4.8.1 Results around a specific unit

To examine material flowrates around a specific unit, return to the flowsheet (option F4 from the main menu) and move the cursor to the desired unit and press <O>. Table 5 gives an example of the results around a hydrocyclone.

4.8.2 Final results

A hard copy of the final results can be obtained by choosing option F7 (Print final results) from the main menu. This provides a listing of all data entered, the results around all units and a complete distribution of material in all the streams. Table 6 gives the complete distribution of material for the first two streams of the flowsheet presented in Figure 5.

Table 5 (a): Results around a hydrocyclone

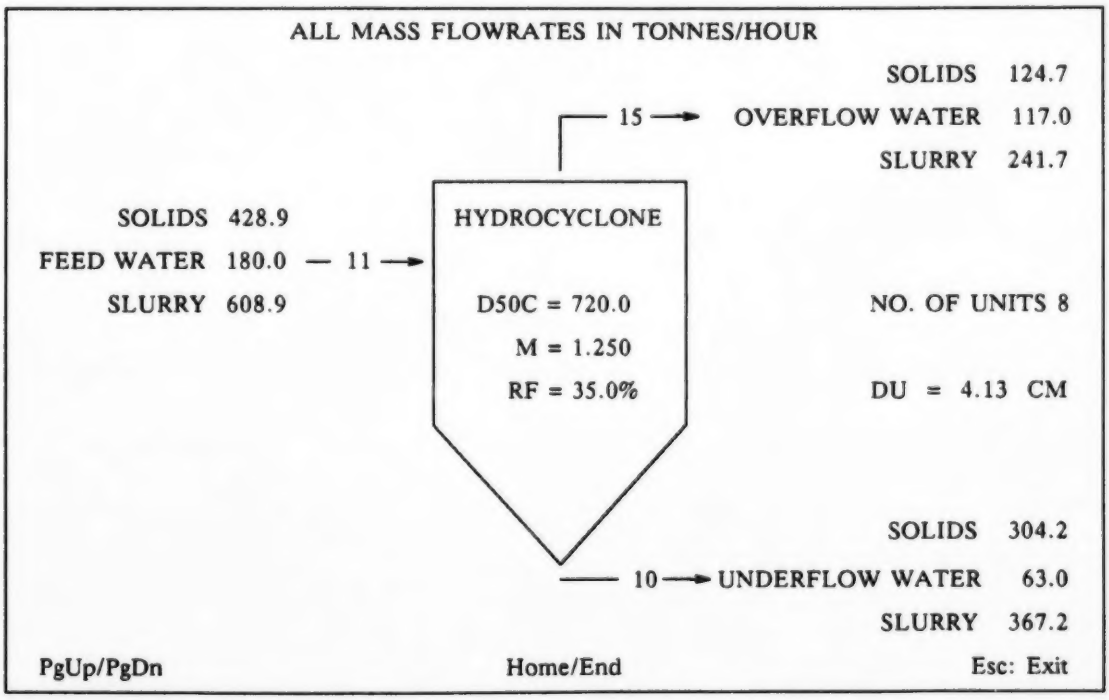

Table 5 (b): Results around a hydrocyclone

PARTICLE SIZE ANALYSES OF FLOWSTREAMS

PARTICLE SIZE MICRONS			FEED (STR#11)	WEIGHT PERCENT UNDERFLOW (STR#10)	OVERFLOW (STR#15)
13454	–	9514	.86	1.22	.00
9514	–	6729	1.89	2.67	.00
6729	–	4758	3.68	5.19	.00
4758	–	3365	6.24	8.78	.03
3365	–	2380	8.29	11.53	.37
2380	–	1683	9.40	12.57	1.66
1683	–	1190	10.31	12.72	4.45
1190	–	841	10.31	11.24	8.01
841	–	595	9.45	8.97	10.62
595	–	421	7.76	6.40	11.07
421	–	297	5.96	4.32	9.96
297	–	210	4.51	2.93	8.34
210	–	149	3.52	2.11	6.96
149	–	105	2.68	1.51	5.54
105	–	0	15.16	7.84	33.00

PgUp/PgDn F9: Keyboard help F10: Continue Esc: Exit

Table 6: Complete distribution of material

GRINDING CIRCUIT SIMULATION RESULTS

STREAM NUMBER	SOLID FLOWRATE	WATER FLOWRATE	% SOLID	SIZE DISTRIBUTION SCREENS	%RET
1	125.0	27.0	82.24	26900. - 19024.	2.80
				19024. - 13454.	11.20
				13454. - 9515.	22.20
				9515. - 6729.	11.40
				6729. - 4759.	10.60
				4759. - 3366.	7.80
				3366. - 2380.	4.60
				2380 - 1683.	4.20
				1683.- 1190.	3.90
				1190. - 842.	2.90
				842. - 595.	2.30
				595. - 421.	1.70
				421. - 298.	1.30
				298. - 210.	1.20
				210. - 0.	11.90
2	125.0	27.0	82.24	26900. - 19024.	.00
				19024. - 13454.	.00
				13454. - 9515.	.44
				9515.- 6729.	1.65
				6729. - 4759.	4.63
				4759. - 3366.	9.19
				3366.- 2380.	11.72
				2380.- 1683.	11.06
				1683. - 1190.	9.84
				1190. - 842.	7.49
				842. - 595.	5.66
				595. - 421.	4.17
				421. - 298.	3.44
				298. - 210.	3.10
				210. - 0.	27.62

5. PROGRAM CAPABILITIES

The limitations in SIMBAL are related to the particular simulation module (HCONEX, SPLITX, GRNDEX and FLOTEX) being used. Table 7 indicates all these limitations. In SPLITX the total number of parameters is fixed at 100 per unit and 1000 for all units.

Table 7: Program limitations

Maximum number of	Simulation module			
	HCONEX	SPLITX	GRNDEX	FLOTEX
streams	80	80	80	80
water additions	9	9	9	9
size intervals	20	20	20	20
specific gravities	10	10	1	10
characteristics	1	4	1	1
units	15	25	25	25
rod mills			1	
ball mills			5	
hydrocyclones			10	
mixers			10	
extrapolation modules			3	

6. SAMPLE RUN

Diskette 4 (SAMPLE RUN) contains a sample run associated with each simulation module: HCONEX.SMB, SPLITX.SMB, GRNDEX.SMB and FLOTEX.SMB. To run them, the user should select the desired simulation module and use option F3 (Retrieve data from file) from the main menu. For further information, the user is referred to SPOC manual, Chapter 6 (11).

7. MAINTENANCE AND UPDATES

CANMET does not provide any formal maintenance of the programs but would appreciate receiving comments on modifications that could substantially improve the overall performance of the program.

8. ACKNOWLEDGEMENTS

The authors gratefully acknowledge J. Leung, R. Pilgrim and D. Cimon for reviewing the manuscript.

9. REFERENCES

1. D. Laguitton and M. Bilodeau, *Computer Aided Mineral Processing: Simulation and Expert Systems*, Proceedings of the Copper 1987 Conference, Vol. 2, Vina del Mar, Chile, November 1987.
2. *Disk Operating System*, Version 3.1, Reference, International Business Machines Corporation (IBM), P.O. BOX 1328–C, Boca Raton, FL 33432, U.S.A., 1985.
3. *Fortran Compiler*, Version 4.01, Microsoft Corporation, 16011 NE 36th WAY, BOX 9717, Redmond, WA 98073–9717, U.S.A., 1987.
4. Peter Norton, *Programmer's Guide to the IBM PC*, Microsoft Press, Bellevue, WA, U.S.A., 1985.
5. *Disk Operating System, Technical Reference*, International Business Machines Corporation (IBM), P.O. BOX 1328–C, Boca Raton, FL 33432, U.S.A., 1985.
6. M. Bilodeau, *Development of Screen Management Subroutines Compatible with Microsoft Fortran Compiler*, CANMET, Energy, Mines and Resources Canada, 1988.
7. *SideKick, The Desktop Organizer*, Borland International, Inc., 4585 Scotts Valley Drive, Scotts Valley, CA 95066, U.S.A., 1985.
8. A.L. Mular, SPOC manual, *Chapter 5: Unit Models and Fortran Simulators of Ore and Coal Process Equipment: Comminution and Flotation*, CANMET, Energy, Mines and Resources Canada, 1985.
9. L.R. Plitt and B.C. Flintoff, SPOC manual, *Chapter 5.1: Unit Models and Fortran Simulators of Ore and Coal Process Equipment: Classification and Coal Processing*, CANMET, Energy, Mines and Resources Canada, 1985.
10. D. Laguitton, F. Flament, J. Wilson and R.F. Pilgrim, SPOC manual, *Chapter 5.2: Unit Models and Fortran Simulators of Ore and Coal Process Equipment: Miscellaneous*, CANMET, Energy, Mines and Resources Canada, 1985.
11. F. Flament, D. Laguitton, E. Ter Heijden and P. Chassat, SPOC manual, *Chapter 6: Plant Simulators for Mineral Dressing*, CANMET, Energy, Mines and Resources Canada, 1985.
12. R.P. King, *MODSIM – A modular method for the design, balancing and simulation of ore dressing plant flowsheets*, Report No. 69, Department of Metallurgy, University of Witwatersand, Johannesburg, South Africa, October 1984.